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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Potential flood volume of Himalayan glacial lakes" *by* K. Fujita et al.

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General: The study presents a valuable approach to calculate the potential flood volume of more than 2000 glacial lakes in the Himalaya and indices for the determination of the potential of an outburst of these lakes. As glacial lake outburst floods represent a serious hazard, the topic of the paper is very relevant not only for the scientific community but also the society. The paper presents some novel aspects such as considering the steepness of the lake front or the systematically use of Hexagon KH-9 data from the 1970s. Overall the methods and results are understandable but as the earlier reviews state some restructuring and further details regarding the methodology are needed for further clarification. I have especially the following comments:

- In line with an earlier review I would like to emphasise that the authors do not present a risk assessment. The risk would include the downstream effect. This risk is affected

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by the potential flood volume but depends on many other factors like the characteristics of the downstream area and the affected land and infrastructure. Please revise the terminology and change “risk” to “hazard”, “outburst probability” or similar based on the context throughout the manuscript. In addition, the authors present important aspects of a hazard assessment but not a full one (e.g. as correctly mentioned in the introduction many factors are important to consider if a glacial lake can be dangerous not only the steepness of the lake front and the lake volume). This should also be more emphasized in the text.

- The quality of the utilized DEM is of high importance for the results. Both ASTER and Hexagon data have limitations for the generation of DEMs. The authors should also use the same resolution for the comparison of the DEMs or deriving parameters from them as the resolution has an impact. Please provide an accuracy assessment and show an example of the generated DEMs.

- I appreciate that the authors include an error assessment. However, it should include all aspects of the data generation (e.g. lake mapping accuracy, uncertainty in the volume estimate, co-registration error) and should be part of the methods section as the uncertainty has impacts on the results.

- The supplementary material presents interesting information which could be included in the main text or presented as an appendix as NHESS has no length restrictions.

Some specific comments are presented below but I do not repeat the major comments from above:

Abstract The abstract presents mainly the methodology. However, some more results should be included as well.

1. Introduction

You may consider the following additional references here and also for the discussion: Huggel et al. (2002), Bolch et al. (2011), Mergili and Schneider (2011). You may

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think about to include information about the location of the dams with respect to the probability of the existence permafrost (cf. Bolch et al. 2011) if existing. There is at least some information available for the Khumbu area (Fukui et al. 2007). Mergili and Schneider (2011) and Bolch et al. (2011) use also declassified imagery (Corona imagery) for the information about the earlier lake areas.

2. Methods

Formula 1: The authors should clearly state that obtaining the depth from the surface area only is subject to high uncertainties and consider these uncertainties in the results and discussion.

P 19, l. 24ff: Generation of DEMs based on Hexagon data is not straight forward and requires the collection of many GCPs and postprocessing. This is a very tedious and time consuming task. Please provide also some more information also about the co-registration procedure of the DEMs and Hexagon images.

P. 20, l. 7ff: Identification of lakes using the NDWI is in general suitable. However, the authors should clearly state the limitations and provide the information how they dealt with them: e.g. turbid lakes, frozen lakes, lakes in shadow, misclassified shadowed areas. How did you identify supraglacial lakes? Visually or automatically using a glacier inventory (if so which one?)

3. Results

The results are quite short. The authors have a huge and very interesting data set and I think more results can be obtained from them, e.g. distribution of lakes, more specific analysis with respect to the location of the lakes with potentially large flood volume (elevation, climatic patterns, debris-covered glaciers etc.). Not all must be done but some more information would increase the significance of the study.

5. Discussion

Please include a more in depth discussion about the strengths and limitations of the

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approach.

I also suggest a more in depth discussion with respect to the literature. Imja is a nice example (The authors may also consider also Watanabe et al. 2009) but not the only one and I am sure that the authors are well aware about the other investigated lakes as partly mentioned in the “Conclusions” section but should be discussed here.

6. Conclusions

The first lines and several other parts are not a conclusion of the study but should rather be moved to the discussion. The first lines are very important statements and here the authors mention implicitly that risk (including the downstream effect) and hazard is not the same. Countermeasures are required if a lake has a high risk but not necessarily if it is highly dangerous.

Figures

Fig. 1: The caption is quite long and describes the methodology and should be stated in the main text. From my point a view a caption should not repeat what was stated in the main text Fig. 2: I would also suggest to shorten the caption and to provide the important information about the constraints of the lake depth only in the main text. Fig. 7a: You may think about presenting lake area in log scale.

References:

Bolch, T., J. Peters, B. Pradhan, A. B. Yegorov, M. F. Buchroithner, and V. P. Blagoveshchenskiy (2011), Identification of potentially dangerous glacial lakes in the northern Tien Shan, Nat. Hazards 59(3), 1691–1714.

Fukui, K., Y. Fujii, Y. Ageta, and K. Asahi (2007), Changes in the lower limit of mountain permafrost between 1973 and 2004 in the Khumbu Himal, the Nepal Himalayas, Global Planet. Change 55(4), 251–256.

Huggel, C., A. Kääb, W. Haeberli, P. Teysseire, and F. Paul (2002), Remote sensing

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based assessment of hazards from glacier lake outbursts: a case study in the Swiss Alps, Canadian Geotechnical Journal 39, 316–330.

Mergili, M., and J. F. Schneider (2011), Regional-scale analysis of lake outburst hazards in the southwestern Pamir, Tajikistan, based on remote sensing and GIS, Nat. Hazards Earth Syst. Sci. 11, 1447–1462.

Watanabe, T., D. Lamsal, and J. D. Ives (2009), Evaluating the growth characteristics of a glacial lake and its degree of danger of outburst flooding: Imja Glacier, Khumbu Himal, Nepal, Norsk Geografisk Tidsskrift - Norwegian Journal of Geography 63(4), 255–267.

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